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White luminescence in borate and phosphate glasses containing lead

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Generation of white light has become a challenging task nowadays as the white light-based devices are considered as important components of human electronic interface. To produce white light by conventional way, a blended set of various phosphors are usually used in fluorescent lamps, so that the wavelengths at which the phosphors emit are distributed evenly. Rare earth doped borate and phosphate glasses [1] belonging to wide family of inorganic glass systems could be considered as favorable alternative luminescent materials replacing conventional phosphors for white LEDs due to their some potential advantages such as, lower production cost, simpler manufacturing procedure, homogeneous light emission and better thermal stability. Among various glass host matrices, borate glasses containing lead [2, 3] have attracted considerable attention, because they possess excellent luminescence properties. Different scientific works focused on rare earth-doped glasses have succeeded in generating white light, although co-doping with at least two different rare earth ions (Ln^{3+}) is necessary and strongly recommended by several co-workers.

Our previous investigations indicate that lead borates doubly doped with Dy^{3+}/Tb^{3+} and Tb^{3+}/Eu^{3+} [4] are the most important glass systems from the optical point of view. Generally, trivalent Tb^{3+} and Eu^{3+} are incorporated to glass host matrices in order to produce systems emitting two primary color (green and red) light. Glass materials containing terbium ions are known as green emitters, due to $^5D_4 \rightarrow {}^7F_5$ transitions, located at about 543 nm. The second Ln^{3+} ions, i.e. trivalent Eu^{3+} ions are often used as a spectroscopic probe in inorganic glasses. Many glass systems demonstrate intense and efficient red emission at 611 nm associated to the $^5D_0 \rightarrow {}^7F_2$ transition of Eu^{3+}. Moreover, quite intense green (Tb^{3+}) and red (Eu^{3+}) luminescence can be produced under excitation by commercially available UV or blue LED in wide 350 - 490 nm range, where several absorption bands of Ln^{3+} (Ln = Tb, Eu) occur. Such primary (green, red) colors emitting materials are of significant importance in the development of emission rich optical systems. White light generation from the simultaneous emissions of blue, green and red lights under UV-light excitation is possible to obtain in Tb^{3+}/Eu^{3+} glass matrices with the presence of the third component giving blue luminescence, for example Dy^{3+}. Thus, these phenomena will be quite well realized in $Dy^{3+}/Tb^{3+}/Eu^{3+}$ triply doped inorganic glasses, which exhibit the ability to address white light as a sum of blue (Dy^{3+}), green (Tb^{3+}) and red (Eu^{3+}) emissions under laser excitation with commercially available solid-state diode lasers.

In this work, we present preliminary results for $Dy^{3+}/Tb^{3+}/Eu^{3+}$ ions in lead borate glasses under different excitation wavelengths. Our investigations clearly indicate that the quite efficient energy transfer processes between rare earth ions in lead borate glass host occur (Fig. 1). The same phenomena were also observed for $Dy^{3+}/Tb^{3+}/Eu^{3+}$ ions in phosphate glasses containing lead.

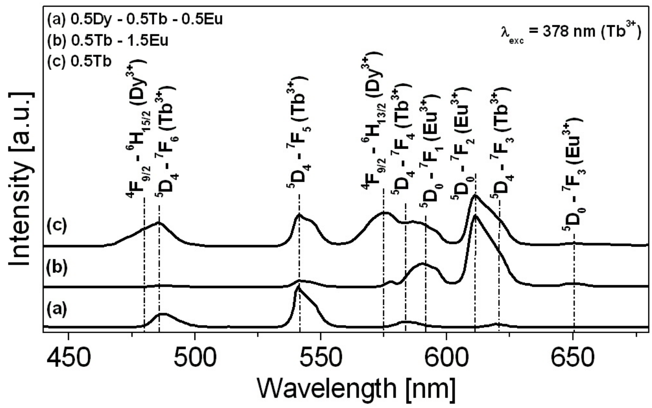

Fig. 49. Luminescence spectra of rare earth ions in borate glasses containing lead.

Generally, these trivalent rare earths are incorporated to glass host matrices in order to produce systems emitting four primary color light: blue and yellow (Dy^{3+}), green (Tb^{3+}) and red (Eu^{3+}) light. Our glasses exhibit nearly white emission originating from the simultaneous generation of several bands of Dy^{3+}, Tb^{3+}, and Eu^{3+} ions under the UV-vis light excitation. The similar effects were also obtained for oxyfluoride silicate glass triply doped with Dy^{3+}/Tb^{3+}/Eu^{3+} [5].

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